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Sex Work among People who Inject Drugs: Impact on Risk Behaviors and their Association with HIV Positivity

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ABSTRACT

Objectives: The objectives of this study were: 1) to examine the correlates of HIV positivity among participants who injected and engaged in sex work in the SurvUDI network between 2004 and 2016, after stratification by sex, and 2) to compare these correlates with those of sexually active participants who did not engage in sex work.

Design and setting: This biobehavioral survey is an open cohort of services where participants who had injected in the past six months were recruited mainly through harm reduction programs in Eastern Central Canada.

Participants: Data from 5476 participants (9223 visits in total; 785 not included in multivariate analyses due to missing values) were included.

Methods: Participants completed an interviewer-administered questionnaire and provided saliva samples for anti-HIV antibody testing. Generalized estimating equations (GEE) taking into account multiple participations were used.

Results: Baseline HIV prevalence was higher among SWs compared to non-SWs (women: 13.0% vs 7.7%; $p < 0.001$, and men: 17.4% vs 10.8%; $p < 0.001$). PWID-SWs were particularly susceptible to HIV infection as a result of higher levels of vulnerability factors and injection risk behaviours. They also presented different risk-taking patterns than their non-SWs counterparts, as shown by differences in correlates of HIV positivity. Additionally, the importance of sex work for HIV infection vary according to gender, as suggested by a large proportion of injection risk behaviours associated with HIV among women and, conversely, a stronger association between sexual behaviors and HIV positivity observed among men.

Conclusion: These results suggest that sex work has an impact on the risk of HIV acquisition and that risk behaviors vary according to gender. Public health practitioners should take those specificities into account when designing HIV prevention interventions aimed at PWIDs.

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Strengths and limitations of this study: 1) Participants might not be representative of all PWIDs in Eastern Central Canada since they were mostly recruited through harm reduction programs. 2) The use of self-reported measures may have led social desirability and recall biases. 3) Causality is uncertain since these are prevalent cases, and behaviors may have occurred before or after the time of infection.

Introduction

People who inject drugs (PWIDs) are a highly marginalised segment of the population as they often experience a variety of challenges, including stigmatisation, discrimination, addiction, economic pressure and social exclusion. Those factors are often associated with high-risk income-generating activities, including the exchange of sex for money, drugs, goods or other things, resulting in an overlap between drug injection and sex work ¹.

PWIDs who also engage in sex work (PWID-SWs) have been identified as a key group with respect to human immunodeficiency virus infection (HIV). In addition to the impact of being exposed to both injection-related and sexual transmission pathways ², the criminalization and stigmatisation of both drug use and sex trade in most countries might lead to an increased risk of health harms, including blood-borne viruses (BBVs)³. Additionally, people who engage in both sex work and drug injection require special attention due to potentially important public health consequences. Given that the HIV epidemic in North America is known to be concentrated among specific key populations, they can potentially serve as a bridge between those and lower risk populations⁴.

Studies conducted in the European region have shown a high risk of HIV infection among people who inject drugs and sell sex⁵⁻⁷. Nonetheless, with limited HIV/AIDS surveillance data among sex workers in North American settings, few studies have examined in detail the association between HIV infection, injection drug use and sex trade involvement in this region^{1,8}. A study published in 2011 highlighted the need for more evidence on this topic by documenting the emergence of sex work as an independent risk factor for HIV infection among PWIDs in Eastern Central Canada ⁹. A subsequent study showed that HIV incidence among PWID-SWs was 2.19 times higher than among those not reporting client sex partners for the 2004-2014 period [adjusted hazard ratio (AHR): 2.19, 95% Confidence Interval (95% CI): 1,13-4.25] ¹⁰. The risk factors for HIV incidence among this key population were also explored, but limited number of seroconversions resulted in a small amount of variables being studied ¹⁰.

Thus, we undertook the present analyses to identify the correlates of HIV positivity among participants who injected and engaged in sex work, after stratification according to sex, in the SurvUDI network, an ongoing biobehavioral survey among PWIDs in Eastern Central Canada. We also compared these correlates with those of sexually active participants who did not engage in sex work.

Methods

Study design and subjects. The complete methodology of the SurvUDI study has been described elsewhere¹¹. Briefly, the SurvUDI network is an ongoing biobehavioural survey for HIV, HCV and associated risk behaviours among PWIDs in Eastern Central Canada. The network was implemented in 1995 and targets hard-to-reach, mostly out-of-treatment PWIDs. Eligibility criteria include being aged 14 and older, injecting at least once within the past 6 months, speaking French or English and being able to provide informed consent. Participants are recruited in urban areas, including Montréal and neighbouring South Shore, Québec City, the Hull-Ottawa region, and five semi-urban areas of the province of Québec. Overall, since 2004, 95.2% of participants were recruited in harm reduction programs. Others were recruited in drop-in centres, detention centres, detoxification clinics, and rehabilitation programmes. Participation includes an interviewer-administered questionnaire and collection of gingival exudate using the Orasure device (Bethlehem, Pennsylvania, US) for HIV and HCV antibody testing. The study design is an open cohort of services where participants who attend harm reduction programs are recruited. PWIDs may participate more than once and be followed longitudinally. The present sample includes sexually active participants recruited from March 1st, 2004 to March 31st, 2016. Participants are identified using an encrypted code based on their initials, birth date and sex, and they are given a stipend ranging from CAN\$5.00 to \$10.00 at the end of each study visit. All procedures have been approved by the ethics committee of the Centre de recherche du CHU de Québec.

Study variables. The dependent variable was HIV positivity. Potential correlates of HIV positivity were identified based on a literature review and on previous analyses on this cohort¹². Variables considered in univariate analyses included age, high school not completed, homelessness, recent incarceration, the region of recruitment (urban or semi-urban/rural), year of recruitment, time since first injection (≥ 6 years), injection partners (always injecting alone, mainly with known people, mainly with strangers), injection with a syringe used by someone else and injection with material other than syringes, such as mixing containers, filters and cottons, used by someone else (never, mainly obtained from known people, mainly obtained from strangers), not having lent their used syringes to others, daily injection in the last month, high number of injections in the last month (≥ 120), cocaine as the most often injected drug, crack/freebase use other than by injection, injection of 2 drugs or more, sex of sexual partners (only male, only female, both male and female), sexual intercourse in the last month, having at least one regular sex partner, having at least one casual sex partner, high number of male sex partners (≥ 21 partners), consistent condom use for vaginal and anal sex (always, not always, no anal or vaginal intercourse), and condom use at the last sexual

intercourse. Sex work was defined as having client sex partners in the past six months, i.e. partners giving money, drugs, goods or other things in exchange for sex. Unless otherwise stated, questions about behaviours referred to the 6 months prior to the interview.

Laboratory procedures. Collected oral fluid samples were kept at 4°C and shipped within 2 weeks to the Laboratoire de santé publique du Québec (LSPQ; Institut national de santé publique du Québec), where they were centrifuged upon reception. The extracted liquid was kept at -20°C for a maximum of 6 weeks until analysis. The presence of HIV antibodies was assessed by enzyme immunoassay (EIA) using HIV-1 Vironostika Microelisa System (bioMérieux, Durham, North Carolina, USA) from 2004 to 2009 and GS HIV-1/HIV-2 PLUS O EIA (Bio-Rad Laboratories (Canada) Ltd., Montréal, Qc, Canada) thereafter. The presence of HCV antibodies was assessed using ORTHO® HCV 3.0 ELISA Test System (Bio-Rad Laboratories (Canada) Ltd., Montréal, Qc, Canada) according to a modified method developed by Judd et al.¹³. Samples were considered negative if results were less than 75% of the cut-off value. Sample results that were greater than 75% of the cut-off value were retested in duplicate. A sample was deemed positive if at least two out of three results were greater than the cutoff value.

Statistical analyses. Cross-sectional sex-stratified descriptive analyses were conducted to compare risk profiles at baseline between participants engaged in SW and other participants. Pearson's chi-squared tests were used for categorical variables and two-sample t-test were used for continuous variables, with Satterthwaite's correction when variances were unequal.

Univariate and multivariate generalized estimating equations (GEE) with Poisson regression and robust variance were carried out for each group (sex workers and non-sex workers, analyzed separately by sex) to assess correlates of HIV positivity^{14,15}, with the prevalence ratio (PR) used as the measure of association. Data collected at all visits were used, and 785 visits were not included in multivariate analyses due to missing values. Variables were considered for inclusion in the multivariate analyses if they had a *p*-value of 0.20 or less in the univariate analysis. The final multivariate analyses included significant variables (*p*-value <0.05) and confounders, i.e. variables changing prevalence ratios by more than 10% when removed from the complete model. Variables that were significant or confounders in one or the other of the two groups (SWs or non-SWs), by sex, were included in both analyses. All analyses were conducted with the SAS statistical suite software version 9.4 (SAS Institute Inc., Cary, NC, U.S.A.).

Results

Characteristics of participants at baseline. A total of 5476 sexually active PWIDs recruited between 2004 and 2016 were included in our analyses. Women comprised 28% of the sample, and respectively 34% (517) and 7% (286) of female and male participants reported sex work.

Women

Overall, the mean age among female participants was 32 years. HIV and HCV prevalence at baseline were higher among female SWs compared to non-SWs (HIV: 13.0% vs 7.7, HCV: 70.4% vs 53.7%). While recruitment region and high school completion were similar among both groups, a higher proportion of female SWs had been incarcerated and reported being homeless in the past six months.

Among female SWs, 11% and 10% respectively reported injection with a syringe and other material used by someone else that had mainly been obtained from strangers, compared to 3% and 4% among non-SWs. Injecting mainly with strangers and reporting having lent used syringes was also more frequent among SWs. Duration and frequency of injection differed by SW status, with female SWs being more likely than non-SWs to have been injecting for at least six years and to report at least 120 injections in the past month. A higher proportion of female SWs also reported cocaine as the most often injected drug as well as the consumption of crack/freebase other than by injection.

Conversely, 32% of female SWs reported the consistent use of condoms for vaginal and anal intercourse, as opposed to 18% among non-SWs. SWs were also more likely to have used condoms at their last sexual intercourse and to report more than 21 male sexual partners.

Men

The mean age among male participants was 36 years. Baseline HIV prevalence was higher among male SWs compared to non-SWs (17.4% vs 10.8%), but this was not the case for HCV prevalence. A higher proportion of male SWs reported having been homeless in the past six months in comparison to non-SWs.

Respectively 20% and 16% of male SWs reported injection with a syringe and other material used by someone else mainly obtained from strangers, compared to 5% and 6% among non-SWs. Injecting mainly with strangers and having lent used syringes to others was also more frequent among SWs. Proportionally more male SWs reported having injected at least 120 times in the past month, reported cocaine as their most often injected drug, and used crack/freebase other than by injection compared to non-SWs.

Male SWs were less likely to consistently use condom and to have used it during their last sexual intercourse than non-SWs. The sex and numbers of partners also differed between those groups, with a total of 77% of male SWs reporting either having only male sex partners or having both male and female partners, compared to 8% among non-SWs. A higher proportion of SWs also reported having had at least 21 male partners in the past six months.

Correlates of HIV positivity. Tables 2 and 3 show univariate and multivariate analyses stratified by sex work among female and male participants.

Women

Age and recruitment in an urban region were both independently associated with HIV among female participants. While not having completed high school was positively associated with HIV positivity among non-SWs only, it almost reached statistical significance among their SWs counterparts. Conversely, female SWs who had been incarcerated recently were more likely to be HIV positive, but this was not the case for non-SWs.

Female SWs who had been injecting since six years or more were more likely to be HIV-positive, and injection with syringes obtained mainly from known persons was positively associated with HIV positivity among this group. A similar association was observed among non-SWs, but only concerned injection with syringes obtained mainly from strangers. Cocaine as the most often injected drug was independently associated with HIV positivity in both groups.

Futhermore, female SWs who reported not having lent used syringes to others were 1.89 times more likely of being HIV-positive compared to those who did not report this behavior. Consistent condom use was also found to be associated with HIV positivity among both groups.

Men

Socio-demographic factors independently associated with HIV positivity among male non-SWs included age and urban recruitment region. Homelessness also appeared as a protective factor among both groups of men.

Men who had been injecting since six years or more were more likely to be HIV-positive, irrespectively of whether they were sex workers or not. Among SWs, injection with material (other than syringes) mainly obtained from known persons was positively associated with HIV positivity. A similar association was

observed among non-SWs, but only concerned injection with syringes mainly obtained from strangers. Both groups of participants who reported not having lent used syringes to others were also more likely of being HIV-positive compared to those who did not report this behavior.

Having had only male sexual partners was one of the strongest correlates of HIV positivity among all male participants, and the highest prevalence at baseline was found among male SWs who inject drugs and have sex with men (20.8%). Consistent condom use was also associated with HIV positivity among non-SWs, suggesting the adoption of protective behaviors, but this association did not remain significant in the multivariate analysis for SWs.

Discussion

The objectives of this study were (1) to examine the correlates of HIV positivity among participants who injected and engaged in sex work in the SurvUDI network between 2004 and 2016, after stratification by sex, and (2) to compare these correlates with those of sexually active participants who did not engage in sex work. We found that a substantial proportion of PWIDs who engage in sex work have experienced homelessness (41% and 55% among women and men, respectively), which has been shown to be associated with higher HIV infection rates among vulnerable populations, including PWIDs^{16–18}. Noticeably, women who reported sex work were more likely to have been incarcerated in the past six months, possibly due to structural conditions such as the criminalized nature of various aspects of sex work in Canada¹⁹, and incarceration appeared as a correlate of HIV positivity among this group.

This study also revealed high levels of risk-taking behaviors among SWs and important differences between SW and non-SWs. Participants involved in sex work reported multiple injection risk behaviours in higher proportion than non-SWs, confirming findings from previous studies^{6,20,21}, and sexual risk-taking differed between female and male participants. While a larger proportion of female SWs reported consistent condom use than their non-SWs counterparts, this phenomenon was not observed among male participants.

Our analyzes did not identify positive associations between sex-related risk behaviours and HIV among female SWs, suggesting that drug injection behaviors might play a more important role in HIV transmission among this group. By contrast, having only male partners was the strongest correlate of HIV positivity among men, and male PWID-SWs who have sex with men were the most likely to be HIV-positive, with a prevalence of 20.8% among this group. Almost half of male SWs also reported having both female and male sexual partners, which appeared to double their chances of being HIV-positive, while no association was found in the case of non-SWs. As suggested elsewhere, those findings indicate that public health practitioners should take the specificities of male PWID-SWs who have sex with men into account when designing prevention programs targeting sexual risk-taking²². A large proportion may not self-identify as homosexual and, as a result, be reached by traditional approaches targeting gay men²².

More positively, our results suggest that HIV-positive PWIDs might adopt behaviors to protect others, such as not lending their used syringes and consistently using condoms. This interpretation is reinforced by the fact that 81.2% of the HIV-positive participants of the SurvUDI network for the 2003-2014 period were aware of their status¹² and by previous research suggesting that HIV-positive individuals who are aware of their own serological status tend to adopt protective behaviors^{23,24}.

Nonetheless, this was not the case among all participants. A positive association between HIV seropositivity and consistent condom use was also observed among sexually active men, but did not reach significance among those who engage in sex work. HIV-positive men who engage in sex work might be less likely to adopt behaviours to protect their sexual partners than those who do not, possibly due to the dynamic between clients and SWs. It has been reported in previous studies that customers of male SWs rarely ever request that the sex worker wears a condom and that if a condom was to be worn, clients might cancel the sexual transaction^{25,26}.

Another hypothesis is that participants might adopt other strategies to reduce the risk of transmission, such as 'serosorting' (sex with other HIV-positive men) or 'strategic positioning' (adoption of a receptive role during unprotected sex). Those methods, which have been found to be used by HIV-positive men in the US in a meta-analysis involving 18,121 men²⁷, can still lead to inadvertent transmission of HIV²⁸. Partners of male PWID-SWs might be at high risk, exposing the need for interventions targeting sexual risk behaviors among this group.

Our study has some limitations. Participants might not be representative of all PWIDs since they were mostly recruited through harm reduction programs, thus possibly leading to the overrepresentation of individuals with more problematic behaviours. Furthermore, the use of self-reported measures may have led to biases because of social desirability, poor recall and intoxication. However, previous studies have shown that PWIDs self-reported behaviours present sufficient validity and reliability^{29,30}. These data should be interpreted with caution since it is not possible to verify whether the observed associations between HIV positivity and risk factors are causal or not since these are prevalent cases, and behaviors may have occurred before or after the time of infection. Finally, these results may not be generalizable to other settings given the importance of the local context in the study of HIV and HCV epidemics among PWIDs.

This study highlighted similarities and differences between PWIDs who engage in SW and those who do not in Eastern Central Canada. Our findings underscore that PWID-SWs are exposed to higher levels of homelessness, incarceration, and injecting risk behaviours than their non-SWs counterparts. PWID also have different risk-taking patterns according to implication in sex work, as shown by differences in correlates of HIV positivity. Additionally, risk-taking patterns differed between women and men, with a larger proportion of injection risk behaviours being associated with HIV among the former and, conversely, a stronger association between sexual behaviors and HIV prevalence being observed among the latter. Public

health practitioners should take those specificities into account when designing HIV prevention interventions aimed at PWIDs.

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No additional data available.

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Table 1. Comparison of Baseline Socio-demographic Characteristics and Risk Behaviours of Sexually Active Participants who Engaged in Sex Work or not, by Sex, 2004-2016

	Female sex workers N (%)	Female non-sex workers N (%)	Test for difference between female SWs and non-SWs (p-value)	Male sex workers N (%)	Male non-sex workers N (%)	Test for difference between male SWs and non-SWs (p-value)
Number of participants	517	1004		286	3669	
Infections						
HIV positivity	67 (13.0)	77 (7.7)	< 0.001	49 (17.4)	395 (10.8)	< 0.001
HCV positivity	364 (70.4)	536 (53.7)	< 0.001	170 (59.7)	2095 (57.3)	0.44
Socio-demographic characteristics						
Age (mean \pm SD)	33.7 (9)	31.8 (10)	< 0.001	33.5 (9)	36.7 (10)	< 0.001
Urban recruitment region	433 (84)	852 (85)	0.57	254 (86)	3139 (86)	0.96
High school not completed	264 (51)	487 (49)	0.41	153 (54)	1828 (50)	0.18
Recent incarceration	62 (12)	61 (6)	< 0.001	41 (14)	526 (14)	0.99
Homelessness	212 (41)	336 (34)	0.003	157 (55)	1526 (42)	< 0.001
Injecting risk behaviours						
Time since first injection (\geq 6 years)	367 (71)	547 (55)	< 0.001	199 (70)	2615 (71)	0.57
Injection partners						
Always injecting alone	107 (21)	199 (20)	< 0.001	63 (22)	998 (27)	< 0.001
Mainly with known persons	186 (36)	558 (56)		59 (21)	1511 (41)	
Mainly with strangers	222 (43)	243 (24)		164 (57)	1149 (31)	
Injection with a syringe used by someone else						
Never	327 (65)	685 (70)	< 0.001	171 (62)	2865 (80)	< 0.001
Mainly obtained from known persons	119 (24)	264 (27)		50 (18)	541 (15)	
Mainly obtained from strangers	55 (11)	31 (3)		54 (20)	190 (5)	
Injection with material used by someone else (other than syringes)						
Never	293 (59)	574 (59)	< 0.001	170 (62)	2605 (73)	< 0.001
Mainly obtained from known persons	151 (31)	367 (38)		63 (23)	729 (21)	
Mainly obtained from strangers	49 (10)	38 (4)		43 (16)	214 (6)	
Not having lent used syringes to someone else	348 (68)	725 (74)	0.03	193 (69)	2961 (82)	< 0.001

Daily injection	230 (45)	384 (39)	0.02	97 (34)	1185 (32)	0.61
High number of injections in the past month (≥ 120)	182 (36)	218 (23)	< 0.001	82 (29)	764 (21)	0.001
Cocaine as the most often injected drug	308 (60)	387 (39)	< 0.001	205 (72)	1970 (54)	< 0.001
Crack/freebase other than by injection	422 (82)	662 (66)	< 0.001	226 (79)	2483 (68)	< 0.001
Sexual risk behaviours						
Consistent condom use for vaginal or anal sex						
Not always	320 (63)	805 (82)	< 0.001	148 (54)	2151 (60)	< 0.001
Always	160 (32)	173 (18)		87 (32)	1295 (36)	
No anal or vaginal intercourse	28 (6)	9 (1)		41 (15)	157 (4)	
Condom use at the last sexual intercourse	339 (66)	436 (44)	< 0.001	165 (58)	2352 (65)	0.03
High number of male sex partners (≥ 21 partners)	253 (49)	8 (1)	< 0.001	63 (22)	9 (0)	< 0.001
Sex of sexual partners						
Opposite sex only	386 (75)	835 (83)	< 0.001	67 (23)	3356 (91)	< 0.001
Same sex only	0 (0)	55 (5)		85 (30)	190 (5)	
Both male and female	131 (25)	114 (11)		134 (47)	123 (3)	

Table 2. Univariate and multivariate Analysis of Correlates of HIV Positivity Among Sexually Active Women According to Sex Work, 2004-2016¹

Variables	Sex workers				Non-sex workers			
	PR	95% CI	APR	95% CI	PR	95% CI	APR	95% CI
Age ²	1.03	[1.01-1.05]	1.03	[1.01-1.05]	1.05	[1.03-1.07]	1.04	[1.01-1.06]
High school not completed	1.27	[0.79-2.04]	1.50	[0.99-2.29]	2.14	[1.30-3.55]	2.14	[1.29-3.56]
Recent incarceration	1.52	[1.00-2.31]	1.66	[1.09-2.54]	0.85	[0.36-2.01]	0.78	[0.30-2.05]
Urban recruitment region	2.99	[1.46-6.13]	2.83	[1.33-6.00]	3.21	[1.43-7.19]	7.73	[2.41-24.82]
Time since first injection (≥6 years)	2.37	[1.25-4.50]	1.79	[1.00-3.21]	2.22	[1.29-3.82]	1.35	[0.76-2.41]
Injection partners								
Always injecting alone	1.00	-	1.00	-	1.00	-	1.00	-
Mainly with known persons	0.54	[0.34-0.87]	0.65	[0.38-1.11]	0.56	[0.37-0.86]	0.65	[0.41-1.02]
Mainly with strangers	0.89	[0.60-1.31]	0.96	[0.63-1.48]	0.41	[0.24-0.70]	0.55	[0.31-0.99]
Injection with a syringe used by someone else								
Never	1.00	-	1.00	-	1.00	-	1.00	-
Mainly obtained from known persons	1.26	[0.83-1.91]	2.21	[1.37-3.56]	0.84	[0.54-1.30]	1.40	[0.85-2.31]
Mainly obtained from strangers	1.32	[0.80-2.18]	1.28	[0.74-2.21]	1.60	[0.83-3.09]	2.49	[1.28-4.85]
Injection with material used by someone else (other than syringes)								
Never	1.00		1.00		1.00	-	1.00	-
Mainly obtained from known persons	0.92	[0.60-1.41]	0.94	[0.57-1.54]	0.66	[0.45-0.99]	1.08	[0.69-1.68]
Mainly obtained from strangers	1.70	[1.10-2.63]	1.87	[1.18-2.98]	1.02	[0.47-2.23]	1.05	[0.48-2.29]
Not having lent used syringes to others	1.60	[1.04-2.48]	1.89	[1.22-2.93]	1.64	[0.97-2.79]	1.41	[0.79-2.50]
Cocaine as the most often injected drug	1.44	[0.93-2.21]	1.59	[1.03-2.44]	1.96	[1.30-2.96]	1.74	[1.15-2.65]
Consistent condom use for vaginal or anal sex								
Not always	1.00		1.00		1.00		1.00	
Always	1.70	[1.18-2.45]	1.67	[1.18-2.35]	1.95	[1.30-2.92]	1.65	[1.09-2.49]
No anal or vaginal intercourse	1.91	[1.10-3.33]	1.82	[1.00-3.33]	0.40	[0.06-2.83]	0.25	[0.03-1.74]
Casual sexual partners	0.64	[0.45-0.90]	0.81	[0.57-1.13]	0.81	[0.58-1.14]	0.82	[0.58-1.17]

¹ Generalized estimating equations, multivariate analyses performed using n = 901 visits (118 not included due to missing values) for women who reported sex work and n = 1452 visits (150 not included due to missing values) for women who did not report sex work.

² Treated as a continuous variable.

PR, prevalence ratio; APR, adjusted prevalence ratio; CI, confidence interval.

Table 3. Univariate and multivariate Analysis of Correlates of HIV Positivity Among Sexually Active Men According to Sex Work, 2004-2016¹

Variables	Sex workers				Non-sex workers			
	PR	95% CI	APR	95% CI	PR	95% CI	APR	95% CI
Age ²	1.02	[1.00-1.04]	1.02	[0.99-1.05]	1.05	[1.04-1.06]	1.02	[1.01-1.04]
Urban recruitment region	2.80	[0.87-8.99]	3.70	[0.95-14.47]	2.18	[1.51-3.16]	1.88	[1.31-2.69]
Homelessness	0.72	[0.49-1.04]	0.61	[0.42-0.89]	0.69	[0.57-0.83]	0.75	[0.62-0.92]
Year of recruitment ²	0.96	[0.90-1.01]	0.96	[0.90-1.02]	0.98	[0.96-1.01]	0.98	[0.95-1.01]
Time since first injection (≥6 years)	3.65	[1.76-7.58]	2.61	[1.20-5.69]	3.44	[2.46-4.81]	2.49	[1.75-3.55]
Injection partners								
Always injected alone	1.00	-	1.00	-	1.00	-	1.00	-
Mainly with known persons	0.85	[0.45-1.58]	1.28	[0.66-2.47]	1.00	[0.79-1.26]	1.17	[0.92-1.48]
Mainly with strangers	1.32	[0.77-2.25]	1.63	[0.96-2.74]	1.05	[0.84-1.31]	1.12	[0.90-1.40]
Injection with syringes used by someone else								
Never	1.00	-	1.00	-	1.00	-	1.00	-
Mainly obtained from known persons	1.15	[0.69-1.92]	1.12	[0.70-1.80]	0.82	[0.63-1.06]	1.20	[0.90-1.61]
Mainly obtained from strangers	1.08	[0.67-1.72]	1.19	[0.67-2.09]	1.67	[1.25-2.24]	1.83	[1.39-2.42]
Injection with materials used by someone else (other than syringes)								
Never	1.00	-	1.00	-	1.00	-	1.00	-
Mainly obtained from known persons	1.24	[0.84-1.85]	1.83	[1.13-2.95]	0.77	[0.61-0.95]	1.12	[0.87-1.43]
Mainly obtained from strangers	0.85	[0.49-1.48]	1.04	[0.60-1.82]	1.02	[0.74-1.40]	1.04	[0.78-1.39]
Not having lent used syringes to others	1.33	[0.85-2.09]	1.59	[1.03-2.47]	1.58	[1.16-2.15]	1.36	[1.03-1.81]
High number of injections in the past month (≥ 120)	1.39	[0.96-2.02]	1.43	[0.97-2.10]	0.89	[0.73-1.09]	1.00	[0.82-1.21]
Cocaine as the most often injected drug	2.43	[1.23-4.81]	2.14	[0.93-4.91]	2.07	[1.64-2.65]	1.53	[1.18-1.98]
Consistent condom use for vaginal or anal sex								
Not always	1.00	-	1.00	-	1.00	-	1.00	-
Always	2.46	[1.52-3.98]	1.49	[0.93-2.40]	2.61	[2.11-3.23]	2.50	[2.01-3.10]
No anal or vaginal intercourse	1.29	[0.70-2.36]	0.84	[0.41-1.70]	3.43	[2.53-4.63]	1.78	[1.29-2.45]
Condom use at the last sexual intercourse	2.54	[1.67-3.88]	2.36	[1.50-3.71]	1.51	[1.23-1.85]	0.91	[0.75-1.10]
Sex of sexual partners								
Only female	1.00	-	1.00	-	1.00	-	1.00	-
Only male	1.71	[0.92-3.17]	2.76	[1.31-5.84]	3.20	[2.48-4.13]	2.31	[1.72-3.09]
Both male and female	1.52	[0.81-2.85]	2.31	[1.16-4.61]	1.20	[0.80-1.81]	1.07	[0.64-1.79]

¹Generalized estimating equations, multivariate analyses performed using n = 445 visits (86 not included due to missing values) for men who reported sex work and n = 5404 visits (669 not included due to missing values) for men who did not report sex work.

²Treated as continuous variables.

PR, proportion ratio; APR, adjusted proportion ratio; CI, confidence interval.

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STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any pre-specified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	4
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed Case-control study—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4-5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	5
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed	

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	not applicable
		(e) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	not applicable
		(c) Consider use of a flow diagram	not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7, Table 1
		(b) Indicate number of participants with missing data for each variable of interest	5 (global)
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 2, table 3
		(b) Report category boundaries when continuous variables were categorized	not applicable
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	not relevant
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	No other analyses
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Impact of Sex Work on Risk Behaviors and their Association with HIV Positivity among People Who Inject Drugs in Eastern Central Canada: Cross-Sectional Results from an Open Cohort Study

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Impact of Sex Work on Risk Behaviors and their Association with HIV Positivity among People Who Inject Drugs in Eastern Central Canada: Cross-Sectional Results from an Open Cohort Study'

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All authors contributed to the study. L.C., K.B. and C.B. undertook the analyses and L.C. drafted the article. É.R., C.M., P.L. and M.A. contributed to the design of the study. B.S. performed and validated laboratory procedures. All authors provided feedback on drafts, approved the final version and agreeded to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Running title: HIV and Sex Work among People who Inject Drugs

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ABSTRACT

Objectives: The objectives of this study were: 1) to examine the correlates of human immunodeficiency virus (HIV) positivity among participants who injected drugs and engaged in sex work (PWID-SW) in the SurvUDI network between 2004 and 2016, after stratification by sex, and 2) to compare these correlates with those of sexually active participants who did not engage in sex work (SW).

Design and setting: This biobehavioral survey is an open cohort of services where participants who had injected in the past six months were recruited mainly through harm reduction programs in Eastern Central Canada.

Participants: Data from 5476 participants (9223 visits in total; 785 not included in multivariate analyses due to missing values) were included.

Methods: Participants completed an interviewer-administered questionnaire and provided saliva samples for anti-HIV antibody testing. Generalized estimating equations (GEE) taking into account multiple participations were used.

Results: Baseline HIV prevalence was higher among SWs compared to non-SWs (women: 13.0% vs 7.7%; $p < 0.001$, and men: 17.4% vs 10.8%; $p < 0.001$). PWID-SWs were particularly susceptible to HIV infection as a result of higher levels of vulnerability factors and injection risk behaviours. They also presented different risk-taking patterns than their non-SWs counterparts, as shown by differences in correlates of HIV positivity. Additionally, the importance of sex work for HIV infection vary according to gender, as suggested by a large proportion of injection risk behaviours associated with HIV among women and, conversely, a stronger association between sexual behaviors and HIV positivity observed among men.

Conclusion: These results suggest that sex work has an impact on the risk of HIV acquisition and that risk behaviors vary according to gender. Public health practitioners should take those specificities into account when designing HIV prevention interventions aimed at PWIDs.

Word count (abstract): 279; **Keywords:** Canada, HIV prevalence, risk factors, injection, sex work

Strengths and limitations of this study: 1) The study used a large geographical coverage including eight Quebec regions and Ottawa as well as urban and rural sites. 2) The method was stable over time and the questionnaire was comprehensive, including injection behaviours, sexual behaviours and some clinical informations. 3) Participants might not be representative of all PWIDs in Eastern Central Canada since they

were mostly recruited through harm reduction programs. 4) Similarly to other observational cohort studies, social desirability and recall biases cannot be ruled out due to the use of self-reported measures. 5) Causal relationships could not be established owing to the use of prevalent cases. Behaviors may have occurred before or after the time of infection.

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Introduction

People who inject drugs (PWIDs) are a highly marginalised segment of the population as they often experience a variety of challenges, including stigmatisation, discrimination, addiction, economic pressure and social exclusion. Those factors are often associated with high-risk income-generating activities, including the exchange of sex for money, drugs, goods or other things, resulting in an overlap between drug injection and sex work ¹.

PWIDs who also engage in sex work (PWID-SWs) have been identified as a key group with respect to human immunodeficiency virus infection (HIV). In addition to the impact of being exposed to both injection-related and sexual transmission pathways ², the criminalization and stigmatisation of both drug use and sex trade in most countries might lead to an increased risk of health harms, including blood-borne viruses (BBVs)³. Additionally, people who engage in both sex work and drug injection require special attention due to potentially important public health consequences. Given that the HIV epidemic in North America is known to be concentrated among specific key populations, they can potentially serve as a bridge between those and lower risk populations⁴.

Studies conducted in the European region have shown a high risk of HIV infection among people who inject drugs and sell sex⁵⁻⁷. Nonetheless, with limited HIV/AIDS surveillance data among sex workers in North American settings, few studies have examined in detail the association between HIV infection, injection drug use and sex trade involvement in this region^{1,8}. A study published in 2011 highlighted the need for more evidence on this topic by documenting the emergence of sex work as an independent risk factor for HIV infection among PWIDs in Eastern Central Canada ⁹. A subsequent study showed that HIV incidence among PWID-SWs was 2.19 times higher than among those not reporting client sex partners for the 2004-2014 period [adjusted hazard ratio (AHR): 2.19, 95% Confidence Interval (95% CI): 1.13-4.25] ¹⁰. The risk factors for HIV incidence among this key population were also explored, but limited number of seroconversions resulted in a small amount of variables being studied ¹⁰.

Thus, we undertook the present analyses to identify the correlates of HIV positivity among participants who injected and engaged in sex work, after stratification according to sex, in the SurvUDI network, an ongoing biobehavioral survey among PWIDs in Eastern Central Canada. We also compared these correlates with those of sexually active participants who did not engage in sex work. We hypothesized that, in addition to injection behaviours, risky sexual behaviours would be associated with HIV positivity, especially in men reporting sex work and sex with men.

Methods

Study design and subjects. The complete methodology of the SurvUDI study has been described elsewhere¹¹. Briefly, the SurvUDI network is an ongoing biobehavioural survey for HIV, HCV and associated risk behaviours among PWIDs in Eastern Central Canada. The network was implemented in 1995 and targets hard-to-reach, mostly out-of-treatment PWIDs. Eligibility criteria include being aged 14 and older, injecting at least once within the past 6 months, speaking French or English and being able to provide informed consent. Participants are recruited in urban areas, including Montréal and neighbouring South Shore, Québec City, the Hull-Ottawa region, and five semi-urban areas of the province of Québec. Overall, since 2004, 95.2% of participants were recruited in harm reduction programs. Others were recruited in drop-in centres, detention centres, detoxification clinics, and rehabilitation programmes. Participation includes an interviewer-administered questionnaire and collection of gingival exudate using the Orasure device (Bethlehem, Pennsylvania, US) for HIV and HCV antibody testing. The study design is an open cohort of services where participants who attend harm reduction programs are recruited. PWIDs may participate more than once and be followed longitudinally. The present sample includes sexually active participants recruited from March 1st, 2004 to March 31st, 2016. Participants are identified using an encrypted code based on their initials, birth date and sex, and they are given a stipend ranging from CAN\$5.00 to \$10.00 at the end of each study visit. All procedures have been approved by the ethics committee of the Centre de recherche du CHU de Québec.

Study variables. The dependent variable was HIV positivity. Potential correlates of HIV positivity were identified based on a literature review and on previous analyses on this cohort^{10,12}. Variables considered in univariate analyses included age, high school not completed, homelessness, recent incarceration, the region of recruitment (urban or semi-urban/rural), year of recruitment, time since first injection (≥ 6 years), injection partners (always injecting alone, mainly with known people, mainly with strangers), injection with a syringe used by someone else and injection with material other than syringes, such as mixing containers, filters and cottons, used by someone else (never, mainly obtained from known people, mainly obtained from strangers), not having lent their used syringes to others, daily injection in the last month, high number of injections in the last month (≥ 120), cocaine as the most often injected drug, crack/freebase use other than by injection, injection of 2 drugs or more, sex of sexual partners (only male, only female, both male and female), sexual intercourse in the last month, having at least one regular sex partner, having at least one casual sex partner, having anal, vaginal or oral sex according to partner type (regular, casual, client), high number of male sex partners (≥ 21 partners), consistent condom use for vaginal and anal sex (always, not

always, no anal or vaginal intercourse; and separately for anal, vaginal and oral sex according to partner type (regular, casual, client), and condom use at the last sexual intercourse. Sex work was defined as having client sex partners in the past six months, i.e. partners giving money, drugs, goods or other things in exchange for sex. Unless otherwise stated, questions about behaviours referred to the 6 months prior to the interview.

Laboratory procedures. Collected oral fluid samples were kept at 4°C and shipped within 2 weeks to the Laboratoire de santé publique du Québec (LSPQ; Institut national de santé publique du Québec), where they were centrifuged upon reception. The extracted liquid was kept at -20°C for a maximum of 6 weeks until analysis. The presence of HIV antibodies was assessed by enzyme immunoassay (EIA) using HIV-1 Vironostika Microelisa System (bioMérieux, Durham, North Carolina, USA) from 2004 to 2009 and GS HIV-1/HIV-2 PLUS O EIA (Bio-Rad Laboratories (Canada) Ltd., Montréal, Qc, Canada) thereafter. The presence of HCV antibodies was assessed using ORTHO® HCV 3.0 ELISA Test System (Bio-Rad Laboratories (Canada) Ltd., Montréal, Qc, Canada) according to a modified method developed by Judd et al.¹³. Samples were considered negative if results were less than 75% of the cut-off value. Sample results that were greater than 75% of the cut-off value were retested in duplicate. A sample was deemed positive if at least two out of three results were greater than the cutoff value.

Statistical analyses. Cross-sectional sex-stratified descriptive analyses were conducted to compare risk profiles at baseline between participants engaged in SW and other participants. Pearson's chi-squared tests were used for categorical variables and two-sample t-test were used for continuous variables, with Satterthwaite's correction when variances were unequal.

Univariate and multivariate generalized estimating equations (GEE) with Poisson regression and robust variance were carried out for each group (sex workers and non-sex workers, analyzed separately by sex) to assess correlates of HIV positivity^{14,15}, with the prevalence ratio (PR) used as the measure of association. Data collected at all visits were used, and 785 visits were not included in multivariate analyses due to missing values. Variables were considered for inclusion in the multivariate analyses if they had a *p*-value of 0.20 or less in the univariate analysis. The final multivariate analyses included significant variables (*p*-value <0.05) and confounders, i.e. variables changing prevalence ratios by more than 10% when removed from the complete model. Variables that were significant or confounders in one or the other of the two groups (SWs or non-SWs), by sex, were included in both analyses. All analyses were conducted with the SAS statistical suite software version 9.4 (SAS Institute Inc., Cary, NC, U.S.A.).

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7 **Results**

8 **Characteristics of participants at baseline.** A total of 5476 sexually active PWIDs recruited between 2004

9 and 2016 were included in our analyses. Women comprised 28% of the sample, and respectively 34% (517)

10 and 7% (286) of female and male participants reported sex work. Among the HIV-positive participants,

11 including both sexes as well as SWs and non-SWs, 78,7% were aware of their status. Among those, 87,9%

12 had consulted a doctor about HIV in the past six months, and 59.3% were on antiretroviral therapy (ART)

13 (results not shown). Baseline characteristics of the participants are shown in Table 1.

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19 *Women*

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21 Overall, the mean age among female participants was 32 years. HIV and HCV prevalence at baseline were

22 higher among female SWs compared to non-SWs (HIV: 13.0% vs 7.7, HCV: 70.4% vs 53.7%). While

23 recruitment region and high school completion were similar among both groups, a higher proportion of

24 female SWs had been incarcerated and reported being homeless in the past six months.

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29 Among female SWs, 11% and 10% respectively reported injection with a syringe and other material used by

30 someone else that had mainly been obtained from strangers, compared to 3% and 4% among non-SWs.

31 Injecting mainly with strangers and reporting having lent used syringes was also more frequent among

32 SWs. Duration and frequency of injection differed by SW status, with female SWs being more likely than

33 non-SWs to have been injecting for at least six years and to report at least 120 injections in the past month.

34 A higher proportion of female SWs also reported cocaine as the most often injected drug as well as the

35 consumption of crack/freebase other than by injection.

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41 Conversely, 32% of female SWs reported the consistent use of condoms for vaginal and anal intercourse,

42 as opposed to 18% among non-SWs. SWs were also more likely to have used condoms at their last sexual

43 intercourse and to report more than 21 male sexual partners.

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47 *Men*

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49 The mean age among male participants was 36 years. Baseline HIV prevalence was higher among male

50 SWs compared to non-SWs (17.4% vs 10.8%), but this was not the case for HCV prevalence. A higher

51 proportion of male SWs reported having been homeless in the past six months in comparison to non-SWs.

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Respectively 20% and 16% of male SWs reported injection with a syringe and other material used by someone else mainly obtained from strangers, compared to 5% and 6% among non-SWs. Injecting mainly with strangers and having lent used syringes to others was also more frequent among SWs. Proportionally more male SWs reported having injected at least 120 times in the past month, reported cocaine as their most often injected drug, and used crack/freebase other than by injection compared to non-SWs.

Male SWs were less likely to consistently use condom and to have used it during their last sexual intercourse than non-SWs. The sex and numbers of partners also differed between those groups, with a total of 77% of male SWs reporting either having only male sex partners or having both male and female partners, compared to 8% among non-SWs. A higher proportion of SWs also reported having had at least 21 male partners in the past six months.

Correlates of HIV positivity. Tables 2 and 3 show univariate and multivariate analyses stratified by sex work among female and male participants.

Women

Age and recruitment in an urban region were both independently associated with HIV among female participants. While not having completed high school was positively associated with HIV positivity among non-SWs only, it almost reached statistical significance among their SWs counterparts. Conversely, female SWs who had been incarcerated recently were more likely to be HIV positive, but this was not the case for non-SWs.

Female SWs who had been injecting since six years or more were more likely to be HIV-positive, and injection with syringes obtained mainly from known persons was positively associated with HIV positivity among this group. A similar association was observed among non-SWs, but only concerned injection with syringes obtained mainly from strangers. Cocaine as the most often injected drug was independently associated with HIV positivity in both groups, and female SWs who reported not having lent used syringes to others were 1.89 times more likely of being HIV-positive compared to those who did not report this behavior.

Furthermore, consistent condom use was found to be associated with HIV positivity among both groups, but having had no anal or vaginal intercourse was positively associated with HIV among SWs only.

Men

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Socio-demographic factors independently associated with HIV positivity among male non-SWs included age and urban recruitment region. Homelessness also appeared as a protective factor among both groups of men.

Men who had been injecting since six years or more were more likely to be HIV-positive, irrespectively of whether they were sex workers or not. Among SWs, injection with material (other than syringes) mainly obtained from known persons was positively associated with HIV positivity. A similar association was observed among non-SWs, but only concerned injection with syringes mainly obtained from strangers. Both groups of participants who reported not having lent used syringes to others were also more likely of being HIV-positive compared to those who did not report this behavior.

Having had only male sexual partners was one of the strongest correlates of HIV positivity among all male participants, and the highest prevalence at baseline was found among male SWs who inject drugs and have sex with men (20.8%). Additionally, having both female and male sexual partners was associated with HIV among SWs, but not among other male participants. Consistent condom use was also a correlate of HIV positivity among non-SWs, but this association did not remain significant in the multivariate analysis for SWs. Conversely, condom use at the last sexual intercourse was correlated with HIV infection among SWs, but not their non-SWs counterparts.

Discussion

The objectives of this study were (1) to examine the correlates of HIV positivity among participants who injected and engaged in sex work in the SurvUDI network between 2004 and 2016, after stratification by sex, and (2) to compare these correlates with those of sexually active participants who did not engage in sex work. Interpretation of findings should take into account that the large majority (78.7%) of the HIV-positive participants of the SurvUDI network for the 2004-2016 period were aware of their status.

While we found that a substantial proportion of PWIDs who engage in sex work have experienced homelessness (41% and 55% among women and men, respectively), homelessness was associated with lower HIV prevalence among men. Considering that a large majority of participants are aware of their status, this result can be interpreted as a higher access to housing subsidies and social programs for people living with HIV, as suggested in a previous study among low-income U.S. urban residents¹⁶. Noticeably, women who reported sex work were more likely to have been incarcerated in the past six months, possibly due to structural conditions such as the criminalized nature of various aspects of sex work in Canada¹⁷, and incarceration appeared as a correlate of HIV positivity among this group.

This study also revealed high levels of risk-taking behaviors among SWs and important differences between SW and non-SWs, including higher HIV prevalence among the former. Participants involved in sex work reported multiple injection risk behaviours in higher proportion than non-SWs, confirming findings from previous studies^{6,18,19} and highlighting the need to prioritize, fund and support services to improve prevention services and linkage to care for this specific sub-group. Sexual risk-taking also differed between female and male participants. While a larger proportion of female SWs reported consistent condom use than their non-SWs counterparts, this phenomenon was not observed among male participants.

Despite having examined a variety of sexual risk behaviors for inclusion in our models, our analyzes did not identify positive associations between sex-related risk behaviours and HIV among female SWs, suggesting that drug injection behaviors might play a more important role in HIV transmission among this group. By contrast, having only male partners was the strongest correlate of HIV positivity among men, and male

PWID-SWs who have sex with men were the most likely to be HIV-positive, with a prevalence of 20.8% among this group. Almost half of male SWs also reported having both female and male sexual partners, which appeared to double their chances of being HIV-positive, while no association was found in the case of non-SWs. These findings confirm our hypothesis that risky sexual behaviours would be associated with HIV positivity among PWID-SWs who have sex with men. This group has a very high HIV prevalence and should be an important focus for intervention. As suggested elsewhere, those findings indicate that public health practitioners should take the specificities of male PWID-SWs who have sex with men into account when designing prevention programs targeting sexual risk-taking²⁰. A large proportion may not self-identify as homosexual and, as a result, be reached by traditional approaches targeting gay men²⁰.

More positively, our results show positive associations between HIV positivity and not lending used syringes as well as consistently using condoms. A plausible explanation for these associations would be reverse causality, i.e. that HIV-positive PWIDs might adopt behaviors to protect others. This interpretation is reinforced by the fact that a large majority (78.7%) of HIV-positive study participants were aware of their HIV positive status and by previous research suggesting that HIV-positive individuals who are aware of their own serological status tend to adopt protective behaviors^{21,22}.

Nonetheless, this was not the case among all participants. A positive association between HIV seropositivity and consistent condom use was also observed among sexually active men, but did not reach significance among those who engage in sex work. HIV-positive men who engage in sex work might be less likely to adopt behaviours to protect their sexual partners than those who do not, possibly due to the dynamic between clients and SWs. It has been reported in previous studies that customers of male SWs rarely ever request that the sex worker wears a condom and that if a condom was to be worn, clients might cancel the sexual transaction^{23,24}.

Another hypothesis is that participants might adopt other strategies to reduce the risk of transmission, such as 'serosorting' (sex with other HIV-positive men) or 'strategic positioning' (adoption of a receptive role during unprotected sex). Those methods, which have been found to be used by HIV-positive men in the US in a meta-analysis involving 18,121 men²⁵, can still lead to inadvertent transmission of HIV²⁶. Partners of male PWID-SWs might be at high risk, exposing the need for interventions targeting sexual risk behaviors among this group.

Amongst the possible limitations of our study, participants might not be representative of all PWIDs since they were mostly recruited through harm reduction programs, thus possibly leading to the

overrepresentation of individuals with more problematic behaviours. Furthermore, the use of self-reported measures may have led to biases because of social desirability, poor recall and intoxication. However, previous studies have shown that PWIDs self-reported behaviours present sufficient validity and reliability^{27,28}. These data should be interpreted with caution since it is not possible to verify whether the observed associations between HIV positivity and risk factors are causal, and behaviors may have occurred before or after the time of infection. Finally, these results may not be generalizable to other settings given the importance of the local context in the study of HIV and HCV epidemics among PWIDs.

This study highlights similarities and differences between PWIDs who engage in SW and those who do not in Eastern Central Canada. Our findings underscore that PWID-SWs are exposed to higher levels of homelessness, incarceration, and injecting risk behaviours than their non-SWs counterparts. PWID also have different risk-taking patterns according to implication in sex work, as shown by differences in correlates of HIV positivity. Additionally, risk-taking patterns differed between women and men, with a larger proportion of injection risk behaviours being associated with HIV among the former and, conversely, a stronger association between sexual behaviors and HIV prevalence being observed among the latter. Public health practitioners should take those specificities into account when designing HIV prevention interventions aimed at PWIDs.

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Table 1. Comparison of Baseline Socio-demographic Characteristics and Risk Behaviours of Sexually Active Participants who Engaged in Sex Work or not, by Sex, 2004-2016

	Female sex workers N (%)	Female non-sex workers N (%)	Test for difference between female SWs and non-SWs (p-value)	Male sex workers N (%)	Male non-sex workers N (%)	Test for difference between male SWs and non-SWs (p-value)
Number of participants	517	1004		286	3669	
Infections						
HIV positivity	67 (13.0)	77 (7.7)	< 0.001	49 (17.4)	395 (10.8)	< 0.001
HCV positivity	364 (70.4)	536 (53.7)	< 0.001	170 (59.7)	2095 (57.3)	0.44
Socio-demographic characteristics						
Age (mean \pm SD)	33.7 (9)	31.8 (10)	< 0.001	33.5 (9)	36.7 (10)	< 0.001
Urban recruitment region	433 (84)	852 (85)	0.57	254 (86)	3139 (86)	0.96
High school not completed	264 (51)	487 (49)	0.41	153 (54)	1828 (50)	0.18
Recent incarceration	62 (12)	61 (6)	< 0.001	41 (14)	526 (14)	0.99
Homelessness	212 (41)	336 (34)	0.003	157 (55)	1526 (42)	< 0.001
Injecting risk behaviours						
Time since first injection (\geq 6 years)	367 (71)	547 (55)	< 0.001	199 (70)	2615 (71)	0.57
Injection partners						
Always injecting alone	107 (21)	199 (20)	< 0.001	63 (22)	998 (27)	< 0.001
Mainly with known persons	186 (36)	558 (56)		59 (21)	1511 (41)	
Mainly with strangers	222 (43)	243 (24)		164 (57)	1149 (31)	
Injection with a syringe used by someone else						
Never	327 (65)	685 (70)	< 0.001	171 (62)	2865 (80)	< 0.001
Mainly obtained from known persons	119 (24)	264 (27)		50 (18)	541 (15)	
Mainly obtained from strangers	55 (11)	31 (3)		54 (20)	190 (5)	
Injection with material used by someone else (other than syringes)						
Never	293 (59)	574 (59)	< 0.001	170 (62)	2605 (73)	< 0.001
Mainly obtained from known persons	151 (31)	367 (38)		63 (23)	729 (21)	
Mainly obtained from strangers	49 (10)	38 (4)		43 (16)	214 (6)	

Not having lent used syringes to someone else	348 (68)	725 (74)	0.03	193 (69)	2961 (82)	< 0.001
Daily injection	230 (45)	384 (39)	0.02	97 (34)	1185 (32)	0.61
High number of injections in the past month (≥ 120)	182 (36)	218 (23)	< 0.001	82 (29)	764 (21)	0.001
Cocaine as the most often injected drug	308 (60)	387 (39)	< 0.001	205 (72)	1970 (54)	< 0.001
Crack/freebase other than by injection	422 (82)	662 (66)	< 0.001	226 (79)	2483 (68)	< 0.001
Sexual risk behaviours						
Consistent condom use for vaginal or anal sex						
Not always	320 (63)	805 (82)	< 0.001	148 (54)	2151 (60)	< 0.001
Always	160 (32)	173 (18)		87 (32)	1295 (36)	
No anal or vaginal intercourse	28 (6)	9 (1)		41 (15)	157 (4)	
Condom use at the last sexual intercourse	339 (66)	436 (44)	< 0.001	165 (58)	2352 (65)	0.03
High number of male sex partners (≥ 21 partners)	253 (49)	8 (1)	< 0.001	63 (22)	9 (0)	< 0.001
Sex of sexual partners						
Opposite sex only	386 (75)	835 (83)	< 0.001	67 (23)	3356 (91)	< 0.001
Same sex only	0 (0)	55 (5)		85 (30)	190 (5)	
Both male and female	131 (25)	114 (11)		134 (47)	123 (3)	

Table 2. Univariate and multivariate Analysis of Correlates of HIV Positivity Among Sexually Active Women According to Sex Work, 2004-2016¹

Variables	Sex workers				Non-sex workers			
	PR	95% CI	APR	95% CI	PR	95% CI	APR	95% CI
Age ²	1.03	[1.01-1.05]	1.03	[1.01-1.05]	1.05	[1.03-1.07]	1.04	[1.01-1.06]
High school not completed	1.27	[0.79-2.04]	1.50	[0.99-2.29]	2.14	[1.30-3.55]	2.14	[1.29-3.56]
Recent incarceration	1.52	[1.00-2.31]	1.66	[1.09-2.54]	0.85	[0.36-2.01]	0.78	[0.30-2.05]
Urban recruitment region	2.99	[1.46-6.13]	2.83	[1.33-6.00]	3.21	[1.43-7.19]	7.73	[2.41-24.82]
Time since first injection (≥6 years)	2.37	[1.25-4.50]	1.79	[1.00-3.21]	2.22	[1.29-3.82]	1.35	[0.76-2.41]
Injection partners								
Always injecting alone	1.00	-	1.00	-	1.00	-	1.00	-
Mainly with known persons	0.54	[0.34-0.87]	0.65	[0.38-1.11]	0.56	[0.37-0.86]	0.65	[0.41-1.02]
Mainly with strangers	0.89	[0.60-1.31]	0.96	[0.63-1.48]	0.41	[0.24-0.70]	0.55	[0.31-0.99]
Injection with a syringe used by someone else								
Never	1.00	-	1.00	-	1.00	-	1.00	-
Mainly obtained from known persons	1.26	[0.83-1.91]	2.21	[1.37-3.56]	0.84	[0.54-1.30]	1.40	[0.85-2.31]
Mainly obtained from strangers	1.32	[0.80-2.18]	1.28	[0.74-2.21]	1.60	[0.83-3.09]	2.49	[1.28-4.85]
Injection with material used by someone else (other than syringes)								
Never	1.00		1.00		1.00	-	1.00	-
Mainly obtained from known persons	0.92	[0.60-1.41]	0.94	[0.57-1.54]	0.66	[0.45-0.99]	1.08	[0.69-1.68]
Mainly obtained from strangers	1.70	[1.10-2.63]	1.87	[1.18-2.98]	1.02	[0.47-2.23]	1.05	[0.48-2.29]
Not having lent used syringes to others	1.60	[1.04-2.48]	1.89	[1.22-2.93]	1.64	[0.97-2.79]	1.41	[0.79-2.50]
Cocaine as the most often injected drug	1.44	[0.93-2.21]	1.59	[1.03-2.44]	1.96	[1.30-2.96]	1.74	[1.15-2.65]
Consistent condom use for vaginal or anal sex								
Not always	1.00		1.00		1.00		1.00	
Always	1.70	[1.18-2.45]	1.67	[1.18-2.35]	1.95	[1.30-2.92]	1.65	[1.09-2.49]
No anal or vaginal intercourse	1.91	[1.10-3.33]	1.82	[1.00-3.33]	0.40	[0.06-2.83]	0.25	[0.03-1.74]
Casual sexual partners	0.64	[0.45-0.90]	0.81	[0.57-1.13]	0.81	[0.58-1.14]	0.82	[0.58-1.17]

¹ Generalized estimating equations, multivariate analyses performed using n = 901 visits (118 not included due to missing values) for women who reported sex work and n = 1452 visits (150 not included due to missing values) for women who did not report sex work.

² Treated as a continuous variable.

PR, prevalence ratio; APR, adjusted prevalence ratio; CI, confidence interval.

Table 3. Univariate and multivariate Analysis of Correlates of HIV Positivity Among Sexually Active Men According to Sex Work, 2004-2016¹

Variables	Sex workers				Non-sex workers			
	PR	95% CI	APR	95% CI	PR	95% CI	APR	95% CI
Age ²	1.02	[1.00-1.04]	1.02	[0.99-1.05]	1.05	[1.04-1.06]	1.02	[1.01-1.04]
Urban recruitment region	2.80	[0.87-8.99]	3.70	[0.95-14.47]	2.18	[1.51-3.16]	1.88	[1.31-2.69]
Homelessness	0.72	[0.49-1.04]	0.61	[0.42-0.89]	0.69	[0.57-0.83]	0.75	[0.62-0.92]
Year of recruitment ²	0.96	[0.90-1.01]	0.96	[0.90-1.02]	0.98	[0.96-1.01]	0.98	[0.95-1.01]
Time since first injection (≥6 years)	3.65	[1.76-7.58]	2.61	[1.20-5.69]	3.44	[2.46-4.81]	2.49	[1.75-3.55]
Injection partners								
Always injected alone	1.00	-	1.00	-	1.00	-	1.00	-
Mainly with known persons	0.85	[0.45-1.58]	1.28	[0.66-2.47]	1.00	[0.79-1.26]	1.17	[0.92-1.48]
Mainly with strangers	1.32	[0.77-2.25]	1.63	[0.96-2.74]	1.05	[0.84-1.31]	1.12	[0.90-1.40]
Injection with syringes used by someone else								
Never	1.00	-	1.00	-	1.00	-	1.00	-
Mainly obtained from known persons	1.15	[0.69-1.92]	1.12	[0.70-1.80]	0.82	[0.63-1.06]	1.20	[0.90-1.61]
Mainly obtained from strangers	1.08	[0.67-1.72]	1.19	[0.67-2.09]	1.67	[1.25-2.24]	1.83	[1.39-2.42]
Injection with materials used by someone else (other than syringes)								
Never	1.00	-	1.00	-	1.00	-	1.00	-
Mainly obtained from known persons	1.24	[0.84-1.85]	1.83	[1.13-2.95]	0.77	[0.61-0.95]	1.12	[0.87-1.43]
Mainly obtained from strangers	0.85	[0.49-1.48]	1.04	[0.60-1.82]	1.02	[0.74-1.40]	1.04	[0.78-1.39]
Not having lent used syringes to others	1.33	[0.85-2.09]	1.59	[1.03-2.47]	1.58	[1.16-2.15]	1.36	[1.03-1.81]
High number of injections in the past month (≥ 120)	1.39	[0.96-2.02]	1.43	[0.97-2.10]	0.89	[0.73-1.09]	1.00	[0.82-1.21]
Cocaine as the most often injected drug	2.43	[1.23-4.81]	2.14	[0.93-4.91]	2.07	[1.64-2.65]	1.53	[1.18-1.98]
Consistent condom use for vaginal or anal sex								
Not always	1.00	-	1.00	-	1.00	-	1.00	-
Always	2.46	[1.52-3.98]	1.49	[0.93-2.40]	2.61	[2.11-3.23]	2.50	[2.01-3.10]
No anal or vaginal intercourse	1.29	[0.70-2.36]	0.84	[0.41-1.70]	3.43	[2.53-4.63]	1.78	[1.29-2.45]
Condom use at the last sexual intercourse	2.54	[1.67-3.88]	2.36	[1.50-3.71]	1.51	[1.23-1.85]	0.91	[0.75-1.10]
Sex of sexual partners								
Only female	1.00	-	1.00	-	1.00	-	1.00	-
Only male	1.71	[0.92-3.17]	2.76	[1.31-5.84]	3.20	[2.48-4.13]	2.31	[1.72-3.09]
Both male and female	1.52	[0.81-2.85]	2.31	[1.16-4.61]	1.20	[0.80-1.81]	1.07	[0.64-1.79]

¹Generalized estimating equations, multivariate analyses performed using n = 445 visits (86 not included due to missing values) for men who reported sex work and n = 5404 visits (669 not included due to missing values) for men who did not report sex work.

²Treated as continuous variables.

PR, proportion ratio; APR, adjusted proportion ratio; CI, confidence interval.

For peer review only

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any pre-specified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	4
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed Case-control study—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4-5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	5
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed	

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	not applicable
		(e) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	not applicable
		(c) Consider use of a flow diagram	not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7, Table 1
		(b) Indicate number of participants with missing data for each variable of interest	5 (global)
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 2, table 3
		(b) Report category boundaries when continuous variables were categorized	not applicable
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	not relevant
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	No other analyses
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.